An Assessment of United States' Policy Concerning GPS

in Light of Current and Planned Changes to the GNSS Environment

Space Law Seminar

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The current United States policy concerning use, implementation, and control of its Global Positioning System (GPS) global navigation satellite system (GNSS) is focused on autonomous control and oversight. The United States has however, for all intents and purposes, guaranteed that it will provide GPS Standard Positioning Service (SPS) navigational data, free of charge, to the entire world for peaceful, civil use. The United States has further enhanced this commitment by its promise to remove the current Selective Availability (SA) controls from GPS thereby providing worldwide access to the more accurate, non-degraded navigational data. In concert with such assurances, the United States has engaged in a campaign to encourage a universal adoption of GPS and GPS navigational data as the sole satellite source of such data for worldwide air traffic control and management and the myriad of other navigation, positioning, and timing applications made possible by GNSS.

As the sole owner/operator of GPS, the United States has, at least to this point, wholly funded the entire GPS development, deployment and operation. Total cost of the GPS system to the United States to date is estimated at $15 billion. It costs $500 million annually to maintain the system and continue its upgrade.

As the sole owner/operator of GPS, the United States is solely liable, at least potentially, for any damage or loss caused by or attributed to the operations of the GPS system. Claims for loss, depending upon the claimant, may be pursued through a number of avenues to include United States domestic law and international agreements.

As the sole owner/operator of GPS, the United States retains complete control over GPS operations. As such, the United States retains the ability to manipulate GPS and its data, and deny others' access to it, should matters of national security so require.

The Russian Global Navigation Satellite System (GLONASS) is, and has been, operational for some time providing GNSS data akin to GPS data. The Russian government has made assurances similar to those of the United States wherein it guarantees access to GLONASS navigational data for civil use. Formerly controlled solely by the Defense Ministry, the Russian government has been actively reaching out to civilian entities and other governments seeking to become partners in an international GNSS. GLONASS is however facing dire straits and its status as a space segment provider in any GNSS is highly questionable.

The European Union (EU) is proceeding full steam ahead with the development and deployment of its own GNSS based upon a space segement referred to as Galileo (formerly referred to as GNSS-2). The European Commission has committed itself to development contracts, and fully expects that the Galileo system will be operational by 2008. Galileo will provide navigational data, though compatible with both GPS and GLONASS, that is independent of GPS and GLONASS and is presumably more accurate than that currently available from either.

Despite the impending existence of three separately owned and controlled GNSS systems, there currently exist no international agreements or constructs which address any aspect of the coordinated control of these systems, the interoperability of these systems, the standardization of these systems, the liability associated with these systems, etc. Proposals have been proffered to address some of these issues, but to date little headway has been made. For its part, the United States has elected to maintain its autonomous stance and shunned efforts to pursue any type of international agreement or consortium directed at managing, controlling, or owning an international GNSS, or standardizing a liability construct addressing GNSS.

Given the current status of GNSS systems, it would appear that the basis for the United States current policy has eroded. It may now be appropriate for the United States to take the lead in establishing an international consortium focused on bringing the current and future GNSS architecture under a common umbrella of management and direction which is internationally binding on all parties.

Global Positioning System (GPS)

The United States Department of Defense (DOD) Navigation System Using Timing and Ranging Global Positioning System (NAVSTAR GPS, or GPS) is comprised of 24 satellites, each of which orbit the earth every 12 hours in one of six orbital planes 10,900 nautical miles above the earth's surface.[1] Four operating satellites are positioned in each of the planes. In orbit, the satellites' dimensions vary depending on generation, but are roughly 5' x 7' x 7' though their accompanying solar panels measure 18 feet across for the Block 2A and 38 feet across for the Block 2R.[2] Each of the satellites continuously transmits two L-band frequency (1575.42 MHz [L1] and 1227.60 MHz [L2]) radio signals.[3] Each signal carries precise time and satellite position data to GPS receivers on the ground, in the air, or in space.

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[1] Tom Logsdon, *Understanding the Navstar: GPS, GIS, and IVHS* (2nd ed. 1995).

[2] Logsdon, *supra* note 1; United States Air Force, *Fact Sheet, NAVSTAR Global Positioning System* (April 1999). The GPS satellites have been developed and deployed thus far in three basic generations. These generations are referred to as Block 1 (which were the initial satellites launched and served primarily as experimental and concept testing and proving platforms), Block 2A (which made up the first operational constellation) and Block 2R (which is the follow on platform to Block 2A and which makes up a portion of the current constellation). The fourth generation, Block 2F is in its final design and development, and initial production stage.

[3] Department of Defense (DOD) and Department of Transportation (DOT), 1999 Federal Radionavigation Plan (hereinafter FRP) at 3-8; Lieutenant Colonel Bill Kaneshiro, USAF, GPS Joint Program Office, Comments at 35th Civil GPS Service Interface Committee (CGSIC) Meeting, March 28, 2000, available at www.navcen.uscg.mil; World Space Systems Briefing,

As the program name indicates, GPS users are able to determine their location using timing and range calculations applied to the information carried on the satellite transmissions. Each satellite signal sent indicates the time the signal was sent and the location of that satellite at that precise moment in time. The GPS receiver receives a satellite signal, identifies the satellite, and records the satellite's position. The receiver then compares the time the satellite sent the signal (which, as noted above, is encoded on the signal) with the time the receiver received the signal (the receiver has its own clock slaved to a master clock). Taking this difference and multiplying it by the speed of sound (the speed at which radio transmissions travel), the receiver can determine its distance, X, from the satellite. The receiver now knows that it is located somewhere on a sphere having the satellite as its center and a diameter of X. The receiver repeats this process for the signals from three other satellites. The receiver now knows it is located at the intersection of these four spheres (four spheres will have only one common point of intersection) and therefore knows its current position.[4] Current GPS receivers can determine location by evaluating data from three to eight satellites.[5] In the case of a three signal calculation, the receiver can determine its location by determining it is at one of two locations (three intersecting spheres have two common points of intersection) and dismissing one of those locations as absurd based on known data (i.e. dismissing a a position fix at 200,000 feet altitude.)

NAVSTAR GPS 2 (1999).

[4] *See* Logsdon, *supra* note 1; *Understanding GPS: Principles and Applications* (Elliott D. Kaplan, editor, 1996); Mitre, *Master GPS WRC-2000 Modular Briefing* (Briefing created by A. Moore and S. Parisi in response to tasking from the Office of the Assistant Secretary of Defense (OASD) C3I/Spectrum Management for presentation of United States position on WRC-2000 agenda items 1.9, 1.15.1, and 1.15.2, December 1999).

[5] Note comments of Lieutenant Colonel Bill Kaneshiro, *supra* note 3, which suggest that operational applications, for all practical purposes, operate on a minimum four signal reception requirement.

To determine velocity, the receiver performs another position solution and notes the distance it has traveled since the time of the previous solution.

This explanation is obviously quite elementary. Its purpose is merely to illustrate the basic geometric principles underlying GPS positioning. The actual calculations occur simultaneously, require adjustments based upon atmospheric conditions, demand continuous time checks and updates to ensure the atomic clocks on the satellites and the receiver clocks are synchronous, etc. Position calculations may also incorporate similar signals from fixed ground-based transmitters which are located at known positions on the earth's surface and which verify the accuracy of the satellite generated signal (and makes corrections as necessary) to augment or improve the accuracy of the GPS system. Incorporation of such ground-based signals is referred to as Differential GPS (DGPS) and is of particular importance to safety-of-life operations (i.e. aircraft takeoff and landing, port entry, etc.)[6]

The GPS program was officially initiated in 1973 under DOD to develop a satellite-based navigation system as a follow-on to the TRANSIT satellite system.[7] The TRANSIT system was a United States Navy satellite system which first became operational in 1965.[8] It was used to locate ballistic missile submarines and surface vessels. Even while TRANSIT was being fine-tuned, the United States Air Force (USAF) was laying the research and development groundwork for GPS through a partnership with Aerospace Corporation as early as 1963. The first of ten developmental GPS satellites, Block 1 satellites, was launched and placed into orbit

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[6] *See* Rand Corporation, *The Global Positioning System: Assessing National Policies* (Study conducted by S. Pace, G. Frost, I. Lachow, D. Frelinger, D. Fossum, D. Wassem, and M. Pinto for the White House Office of Science and Technology Policy, 1995); Mike Shaw, Office of the Secretary of Transportation, Comments at 35th CGSIC Meeting (March 28, 2000) available at www.navcen.uscg.mil.

[7] Air Force News Service, *GPS -- 20th Anniversary* (Feb. 25, 1998); Logsdon, *supra* note 1; World Space Systems Briefing, *supra* note 3, at 11.

[8] Air Force News Service, *supra* note 7; Logsdon, *supra* note 1.

February 22, 1978.[9] Operational GPS satellites, Block II satellites which went into development and production in 1982, began launching on February 14, 1989.[10]

By 1994, DOD had launched 24 Block 2 and 2A satellites, all of which were then operational.[11] DOD now had its first fully operational, global satellite navigation system in place. This is not to say that GPS navigation was not available prior to 1994. U.S. military forces had been using GPS data for operational navigation or supplemental navigation, albeit in a limited mode, since GPS attained initial operational capability in 1989 when the first five Block 2 satellites were in orbit and transmitting. The literature is replete with DOD accounts lauding the success of GPS, which had fifteen operational satellites at the time, and its contributions to the allied operations during the Gulf War in 1991.[12] In many respects, this was GPS's baptism in a high tempo operational context. It passed with rave reviews solidifying user confidence in the system. Since that time, the GPS industry has exploded with new applications being developed constantly from mapping, to tracking, to time-sensitive data transfers (GPS must operate against very precise time constraints and operates to within a millionth of a second time tolerances.)[13] Launches of 3 additional Block 2A satellites continued until 1996 as replacements for earlier satellites which had exceeded their serviceable life and were no longer operational.

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[9] World Space Systems Briefing, *supra* note 3, at 11.
[10] *Id*
[11] *Id.* available at www.navcen.uscg.mil
[12] *See* Richard Drezen, *How It Works; Global Positioning System*, The Washington Post, Dec. 16, 1999, at E4; Rand Corporation, *supra* note 6; United States Air Force, *supra* note 2; World Space Systems Briefing, *supra* note 3, at 11. One interesting aside is that during the Gulf War, many of the receiver units used by soldiers on the ground were basically commercial off the shelf products and therefore only able to receive and process SPS data. To enable the soldiers to have access to more accurate position data, SA was turned off for the duration of the war, but subsequently turned back on, much to the chagrine of commercial users.
[13] United States Air Force, *supra* note 2.

The most current generation of GPS satellites, Block 2R satellites, began to be launched in 1997. There are currently 5 Block 2R satellites in orbit bringing the total number of satellites to 27 (three are held in reserve to replace failed satellites).[14] Eight more Block 2R satellites were forecast to be launched through 2002.[15] However, that launch schedule is being changed for two reasons. First, the current generation of satellites are remaining fully operational longer than expected when initially launched.[16] This service life is a primary driver of subsequent launches.[17] Unless the newer technology of replacement satellites is absolutely necessary to the GPS operation, launching replacement satellites prematurely represents a significant unnecessary revenue expenditure.[18] Secondly, DOD has decided to upgrade the remaining Block 2R satellites with new anti-jamming technology and with the capability to transmit a second signal for use by civilian users over then L2 frequency enabling them to obtain more precise information from the GPS system. This decision to upgrade will likely delay the delivery dates of the remaining Block 2R satellites. According to the GPS Joint Project Office (JPO), a more likely schedule will put the remaining Block 2R satellites in orbit by the end of 2003.[19]

Block 2F satellites, the next generation of GPS satellites with a 15 year expected life span, were slated for delivery in 2001 with launches tentatively scheduled for 2002 and

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[14] Statistics accurate as of Jan. 15, 2000 according to published material. However, Captain Zannis Pappas, USAF, GPS Joint Project Office at the 35th CGSIC Meeting on Mar. 28, 2000 available at www.navcen.uscg.mil suggests that these number are in flux given current launch schedules and the undetermined status of one currently orbiting satellite.

[15] World Space Systems Briefing, *supra* note 3, at 13; Lieutenant Colonel Bill Kaneshiro, *supra* note 3.

[16] Captain Zannis Pappas, *supra* note 14.

[17] Ray Swider, Assistant Secretary of Defense for C4I and Space, Comments at 35th CGSIC Meeting, Mar. 28, 2000 available at www.navcen.uscg.mil. The U.S. launches replacement satellites on a launch on failure basis, that is new satellites are sent into orbit only as current satellites become inoperative.

[18] *See id.*; Lieutenant Colonel Bill Kaneshiro, *supra* note 3.

[19] Lieutenant Colonel Bill Kaneshiro, *supra* note 3; Jeremy Singer, *U.S. Air Force Weighs GPS Upgrade Options*, Space News, Feb. 7, 2000 at 4.

continuing. The current contract for the Block 2F satellites should provide GPS the hardware it needs to maintain operations through at least 2025. Again, with design changes to accommodate new and enhanced signal commitments, a more likely schedule would see the first Block 2F satellites in orbit during 2005 but not reaching initial operational capability until 2012.[20]

Global Navigation Satellite System (GLONASS)

The Global Navigation Satellite System (GLONASS), is the Russian counterpart to GPS. GLONASS is comprised of twenty-four satellites which orbit in one of three orbital planes with 8 satellites evenly spaced in each plane.[21] The satellites orbit at an altitude of 25,440 km (approximately 15,770 nautical miles) with each orbit lasting just over 11 hours.[22] In much the same manner as GPS, GLONASS transmits time and position information over two separate L band frequencies (1246 MHz and 1602 Mhz.)[23]

Development of GLONASS was begun in the mid to late 1970s. In October of 1982, the first GLONASS satellite was launched. As with several of the ensuing launches, the satellites had a life span limited to 2 years or less and were primarily, just as in the case of first generation GPS satellites, experimental platforms. With the launch of GLONASS 782, the sixty-fifth successful GLONASS satellite launch, on December 14, 1995, the Russians attained a fully operational system with a full compliment of 24 satellites.[24]

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[20] Ray Swider, *supra* note 17.
[21] German Aerospace Center, *Introduction to the Russian GLObal Navigation Satellite System GLONASS* (Feb. 2000); The Ministry of Defence of the Russian Federation Coordination Scientific Information Center (KNITs), *GLONASS Constellation* (2000), available at http://mx/iki/rssi/ru/SCFSIC/english.html.
[22] *Id.*
[23] *Id.*
[24] *See* KNITs, *supra* note 21.

Though its orbits and configurations are slightly different than GPS, GLONASS operates on the same basic geometry. Signals from at least four satellites are received, their data is interpolated, and a position is resolved.

Since the December 1995 launch, the Russian government has launched only three GLONASS satellites, all of them launched on December 30, 1998.[25] Prior to and since that launch, operational GLONASS satellites have reached failure without replacement. The full complement of 24 satellites achieved in 1995 was maintained for just a few weeks before older satellites in the constellation became inoperable.[26] At the time of the 1998 launches, only 14 satellites were functioning. Currently, only 9 GLONASS satellites remain healthy and operational.[27] Six of these 9 satellites were launched between July and December of 1995. Historically, the operational GLONASS satellites have averaged about a 5 year life expectancy. If such holds true for these 6 satellites remaining from 1995 launches, the operational integrity of GLONASS is in serious jeopardy without numerous replacement launches in the near future.[28]

Through 1996, confidence remained high that GLONASS was going to remain an accurate and reliable entrant into the global satellite navigation community. Without any form of intentional accuracy degradation through a selective availability feature (such as employed by the U.S.), and with better coverage and accuracy over the polar regions, GLONASS promised to be a significant factor in global navigation, either independently or in concert with GPS.[29] A fledgling

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[25] *Id.*

[26] *Id.*; *See also Launch Should Fill Out GLONASS Constellation*, GPS World, Jan. 1996, at 16.

[27] *See id.*; German Aerospace Center, German Remote Sensing Data Center Webpage which provides current and historical data on the GLONASS constellation as a function of its ongoing operations, available at www.nz.dlr.de; *But see* Mr. Jim Slater, National Imagery and Mapping Agency, Comments at the 35th CGSIC Meeting, Mar. 28, 2000, which suggest that according to data from the International GLONASS Experiment (IGEX) only 8 GLONASS satellites are currently operating in a healthy status.

[28] *See GLONASS Bankrupt?*, SPACE Newsletter, Oct. 26, 1998.

[29] Dr. Jacques Beser, 3S Navigation Company, comments to NATO "Partnership for Peace"

industry was underway producing both GLONASS-only and GLONASS/GPS compatible receivers. European government authorities were expressing a keen interest in forming a partnership with the Russian government to procure GLONASS support for its developing European Geostationary Navigation Overlay System (EGNOS) which would marry GLONASS signals with ground station signals and geostationary orbit satellite signals to provide extremely reliable and accurate positioning data capable of serving as a stand alone navigation and tracking system for European civil aviation.[30] Others were advocating the partnership of GPS and GLONASS as the foundation for an international transportation navigation system.[31]

Russian government decrees were issued in 1995 and 1997 to evidence the Russian government's commitment to and support of the GLONASS system.[32] GLONASS was to receive the full backing and support of the government, earmarking it as a priority program for funding to ensure the continued development of civil navigation. Perhaps signaling the program's current status, President BorisYeltsin issued another decree in early 1999, giving notice that GLONASS was to be overseen jointly by the Defense Ministry and the Russian Space Agency (RSA), that GLONASS was to be used for both military and civilian aims, and most

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seminar, Brussels, Belgium, Nov. 6, 1996; Colonel Michael Lebedev, Chief of Coordination for Science and Information for the Russian Federation, comments to NATO "Partnership for Peace" seminar, Brussels, Belgium, Nov. 6, 1996; *Europe's Interest in GLONASS Grows,* Space News, Nov. 18-24, 1996.

[30] *Launch Should Fill Out GLONASS Constellation, supra* note 26; *Europe's Interest in GLONASS Grows, supra* note 29.

[31] *What Would It Take*, GPS World Newsletter, Nov. 15, 1996.

[32] The Government of the Russian Federation, "On Executing Works in Use of the GLONASS Global Navigation Satellite System for the Sake of Civil User", Decree Number 237, Mar. 7, 1997; The Government of the Russian Federation, "On Federal Aim Program of Using GLONASS Global Navigation Satellite System for the Benefit of Civil Users", Decree Number 1435, Nov. 15, 1997.

importantly, that the Russian government was ready and willing to "...offer the GLONASS system as a basis for the creation of an international global satellite navigation system."[33]

However, even as these ideas were being so enthusiastically advocated, and in fact well before their proffer, the infrastructure supporting GLONASS was crumbling. Reforming the Russian economy has focused on abolishing state oversight of economic activity and concerns, and forcing the state to operate under a budget limited to its tax revenues.[34] The hope is that such efforts will eventually result in establishing a stable, convertible currency. Formerly subsidized enterprises have had to learn to operate and profit in a market economy, not always with success. As a result, for the near term, tax revenues are at a trickle leaving funding available for government activity at a minimum.

Citing an April 1995 Itar-Tass news agency article, Professor Judith Twigg indicates that funding for the RSA, the Russian civilian space program directorate, was cut by 80%, while military space program funding was cut by 90% during the first half of the 1990s. [35] Furthermore, what funding that is appropriated is received sporadically. In 1996, Russian Military Space Forces received less than one-fifth of its allocated budget.[36]

With such minimal cash available, the only activities that have been funded are those that can render a reasonable and foreseeable gain in the short term in the form of hard currency. The space programs have basically fallen back onto existing stores, which primarily consists of rockets and boosters, and focused on providing launch services to commercial enterprises and to

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[33] The President of the Russian Federation, Decree Number 38, Feb. 18, 1999; *Russia Declares GLONASS Satellite Navigation Open for Civilian, World Use*, ITAR-TASS News Agency via British Broadcasting Corporation Worldwide Monitoring, Feb. 18, 1999.
[34] Judyth L. Twigg, *Russia's Space Program: Continued Turmoil*, Space Policy 70 (Vol. 15 1999).
[35] *Id.*
[36] *Id.*

joint ventures with western firms.[37] But those launch assets are drying up much faster than they are being replenished. Only seven new launchers were produced in 1994, despite the fact that half of the already depleted military reserve had been deemed inoperable.[38]

However, RSA and the Russian space industry do predict a brighter, albeit more limited, future for Russian space operations. The operations will be limited in the fact that they will focus on their strong suit, namely providing lift capability to the international market. The RSA director predicts his agency will garner $1.6 billion in revenues from such ventures.[39] That, along with financial support from other governments, should keep a scaled back version of the RSA moving forward on path toward rebuilding a depleted Russian space program that has seen its satellite production grind to a halt, and witnessed a loss of nearly half of the technicians and engineers the Russian space industry employed in 1991.[40]

This all leaves GLONASS very low on the Russian space program's priority list, if even on the list at all, for a number of reasons. GLONASS is only a drain on precious and limited resources. It provides no source of revenue in that the Russians are unable to charge user fees so long as GPS continues in its current no user fee mode. In addition, GLONASS launches would only serve to take otherwise revenue producing launchers away from successful commercial launch efforts. GLONASS research and development has been severely stymied by a lack of funding leaving its technology lagging behind GPS and therefore unable to compete.

In the final analysis, without some tremendous influx of outside capital, the future of GLONASS is quite bleak. With GPS fully funded and operating, and the European Galileo

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[37] *Id.* at 75.
[38] *Id.* at 72.
[39] *Id.* at 75.
[40] *Id.* at 72 citing *Russian Space Chief Voices Dire Warnings*, Aviation Week and Space Technology 26, Jan. 6, 1997 and D. Johnson, *Russia's Military Aviation Industry*, Airpower Journal Volume 2 (1997).

program moving towards operations by the end of the decade, there seems little hope that GLONASS will continue to function as a viable global navigation system past 2001.

Galileo

The European Union's Global Navigation Satellite System 2 (GNSS 2), which is now more often referred to as Galileo, is intended to be an internationally controlled and managed worldwide civil navigation system.[41] Galileo is still in its developmental and definitional phase.[42]

The Galileo space segment, as it is now proposed, will be a constellation of 21-36 satellites placed into one of 5 orbits.[43] The most recent studies and proposals call for an operational configuration of 24 satellites equally divided among three orbital planes in medium earth orbit at an altitude of 14,000 kilometers and an additional eight satellites in geostationary orbit at an altitude of 36,000 kilometers.[44] This configuration is intended to provide consistent and reliable global coverage with a special emphasis towards accuracy in the higher latitudes of many EU member states.[45] As with the GLONASS and GPS systems, the Galileo navigation

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[41] *Agreement between the European Community, the European Space Agency and the European Organisation for the Safety of Air Navigation on a European Contribution to the development of a global navigation satellite system (GNSS)* (hereinafter *Agreement*), European Communities Official Journal L 194 10.07.98, Art. 2.

[42] Commission of the European Communities Press Release RAPID 99/962 Dec. 9, 1999; Martine Mamlouk, European Council representative, comments to 35th CGSIC Meeting, Mar. 28, 2000, available at www.navcen.uscg.mil.

[43] World Space Systems Briefing, *Galileo* (Oct. 1999); *EC Wants Galileo by 2008*, Aviation Daily, Mar. 25, 1999; Jurgen Erdmenger, European Commission Directorate General for Transportation representative, *Results of Option Analysis,* Proceedings of The 12th International Technical Meeting of The Satellite Division of The Institute of Navigation, Sep. 14, 1999.

[44] *EC Wants Galileo by* 2008, *supra* note 43; *The European Space Agency and the European Commission Sign Contracts for the Galileo Programme,* M2 Presswire, Dec. 8, 1999; *European Space Industry Teams Up For Satellite Navigation Programme Galileo,* UKSPACE, Oct. 13, 1999; Martine Mamlouk, *supra*, note 42.

[45] *EC Wants Galileo by* 2008, *supra* note 43.

system will operate on the same geometric principles applied to signals received from a minimum of four satellites to provide near instantaneous position location to users. The purpose of the geostationary satellites will be to provide signal correction data and accuracy verification to receivers of the Galileo signals. The definitional phase of Galileo is to be completed by the end of 2000, with initial implementation slated for 2005 and full operational capability in 2008.[46] Total cost estimates for development and deployment through 2008 range from $2.5 to $3.3 billion U.S.[47]

The history leading up to the current status of Galileo is not all that old, but it is indeed very dynamic. Since the early 1990's, the major European powers have made no secret of their desire to be major factors and contributors in the global navigation satellite system community. By the mid 1990s, research and development was underway on a European Navigation Satellite System (ENSS) which was to be independent of, though compatible with, the then functioning GPS and GLONASS systems.[48] Citing both GPS and GLONASS limited availability and intentionally degraded accuracy as unacceptable, initial investment in ENSS development was made.

At about the same time, the EU was studying the feasibility and viability of an augmented GPS/GLONASS navigation system which has become known as GNSS 1. By 1998, the EU had committed itself to development of GNSS 1 as an "initial implementation of GNSS" (be mindful that the EU is still committed to a GNSS 2 construct as defined above).[49] The EU segment of the

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[46] *The European Space Agency and the European Commission Sign Contracts for the Galileo Programme, supra* note 44.
[47] Michael A. Taverna, *Germany to Play Key Role in* GNSS-2, Aviation Week and Space Technology, Feb. 22, 1999 at 31; *Galileo: It Turns*, Aviation Daily, Feb. 12, 1999.
[48] *Now ENSS,* Aviation Week and Space Technology, Jan. 6, 1997.
[49] *Agreement, supra* note 41 at Annex I; *EGNOS,* Aviation Week and Space Technology, Nov. 30, 1998.

GNSS 1 system is to marry GPS and GLONASS signal data with a European component referred to as the European Geostationary Navigation Overlay Service (EGNOS) to provide highly accurate position information to users in and around the EU.[50] Using data from navigational transponders on board three geostationary INMARSAT satellites (two of which are already in orbit and another which is scheduled for launch in 2000) and information from land-based Ranging and Integrity Monitoring Stations (RIMS), the EU intends to provide highly accurate navigation and position data to users that, with the cooperation of the International Civil Aviation Organization (ICAO) and Joint Aviation Authorities (JAA) oversight, is precise enough to be certified for civil aviation use.[51]

EGNOS is on schedule to be deployed by 2002 and, provided it is certified by the ICAO and JAA, will be fully operational by 2005.[52] To date, eight EU member states (Spain, Portugal, France, Germany, Italy, United Kingdom, Norway and Switzerland) have signed bilateral agreements with the European Space Agency (ESA) establishing the terms of cooperation in support of EGNOS.[53] EGNOS is intended to be fully compatible with the United States Wide Area Augmentation System (WAAS) and Japan's Multi-Transport Satellite Augmentation System (MTSAS) which, when deployed, will offer similar navigation service and bring a true (if only partial) GNSS 1 on line.[54] If EGNOS is to provide a sole means of navigation system for all phases of flight including Category 1 precision approaches it will require deployment of a fourth geostationary satellite.[55]

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[50] Michael A. Taverna, *GNSS Moves a Step Closer to Reality,* Aviation Week and Space Technology, June 29, 1998 at 40; *EGNOS Closer to Implementation*, Aviation Daily, Jan. 27, 1999; *Agreement, supra* note 41 at Annex II.
[51] *Agreement, supra* note 41 at Annex II.
[52] *Groundwork for EGNOS,* Flight International, June 24-30, 1998.
[53] *EGNOS Closer to Implementation*, supra note 50.
[54] *Id.*
[55] Michael A. Taverna, *supra* note 50.

With a firm commitment to EGNOS and GNSS 1 in place, the EU officially began to focus some of its attention on GNSS 2 with a determination of the role the EU should pursue within a GNSS 2 operation in accord with their intentions as set out at the 1994 European Civil Aviation Conference and ensuing Community resolutions. In January 1998, the European Commission, in light of its discussion and analysis, issued a communication which spelled out some of the overarching criteria it deemed essential to any discussion of EU involvement in GNSS 2.[56] The Commission advocated that the GNSS 2 must be efficient and cost-effective, meet both civil and military needs, ensure a high level of safety, ensure the European industry is able to compete in the satellite navigation markets, guarantee service without disruption, give the EU a full role in control of the system, and ensure full European participation in development.[57] Finally, in perhaps a harbinger of the current state of affairs, the Commission noted that "[i]f an international partnership proves impossible, or incapable of meeting the conditions [above], the Union will need to opt for an independent system."[58]

In June 1998, an agreement was reached between the European Community, the ESA, and the European Organization addressing what the European contribution to development of a global navigation satellite system would entail.[59] The parties agreed to cooperate on the study and design of potential system configurations for a GNSS 2 system, setting 2000 as a deadline for completion of such research.[60] This agreement was a significant advance and served as affirmation of the EU's commitment to ultimately see deployment of a civilian controlled GNSS.

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[56] European Commission, *Towards a Trans-European Positioning and Navigation Network together with a European strategy for a global navigation satellite system (GNSS)*, Communication, Jan. 21, 1998.
[57] *Id.*
[58] *Id.*
[59] *Agreement, supra* note 41.
[60] *Id.* at Annex II.

At the time of the agreement, several options were being explored, including cooperative efforts with the United States and Russia.[61] Nevertheless, on the heels of this agreement and with the firm support of the United Kingdom, Italy, Germany, and France, the ESA approved over $40 million U.S. funding for preliminary study of an independent European GNSS system.[62]

At the GNSS 98 Symposium at Toulouse in October 1998, Neil Kinnock, the European Commissioner for Transport Policy, summarized the then-current status of GNSS and urged the EU to move forward full force in staking out a European position within GNSS.[63] Mr. Kinnock indicated that despite talks with the United States, there was "...no prospect of joint ownership and control of the core GPS...."[64] Given the European's criteria that any GNSS must necessarily involve EU control, their options for GNSS participation were now effectively limited to deploying an independent European system. Mr. Kinnock did note the potential upside of a cooperative effort with the Russians, namely access to their frequency allocations, orbital slots, and invaluable experience, given the Russians own enthusiasm to engage in GNSS partnership.[65]

While Mr. Kinnock was very diplomatic in assessing and presenting the underlying basis for the EU's need to press forward with an independent system, and forego continued reliance on GPS, others have been more straightforward in rebutting continued EU reliance on a GNSS system dependent on GPS and U.S. control. At the recent Paris Space and Society Symposium, officials and industry leaders expressed their concerns over continued reliance on GPS-based navigation systems. The two most prominent concerns focused on the lack of guarantee of GPS

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[61] Michael A. Taverna, *supra* note 50.
[62] *Id.*
[63] Neil Kinnock, European Commissioner responsible for Transport and Trans-European Networks, *European Strategy or GNSS (global navigation satellite systems),* address to GNSS 98 Symposium, Oct. 20, 1998.
[64] *Id.*
[65] *Id.*

signal viability, and the competitive disadvantage EU industry faced if the U.S. remained in sole control of GNSS.[66] As some officials noted, "...a global navigation system financed and operated by one nation's military is by definition unstable."[67] With some estimates suggesting that the worldwide satellite navigation market could be worth $50 billion by the end of the decade, officials and industry leaders alike want to ensure European industry can compete for a significant share of that market.[68] In a GPS only environment, business leaders worry that U.S. enterprises would have access to GPS developments and enhancements ahead of the rest of the world giving them a decided advantage in getting new products to market.[69] These sentiments and concerns were similarly expressed in a 1999 European Commission communication advocating full scale development of Galileo which stated as its objective "...to reduce the European Union's dependence on the American GPS system for strategic and economic reasons."[70] The reader will note that in the span of one year, from January 1998 to February 1999, the Commission's position moved from examining GNSS options, to include a cooperative GPS based effort, to total focus on an independent European system.

These sentiments aside, the EU is yet committed to deploying a GNSS system that is "fully compatible with but independent of GPS."[71] In fact, the EU recognizes that, in the grand scheme, the next generation GNSS can only be completely successful if there is EU-U.S.

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[66] Peter B. de Selding, *GPS Concerns Spur European Support for Galileo Program*, Space News, Dec. 20, 1999, at 11.
[67] *Id.*
[68] Neil Kinnock, *supra* note 63; *See also* Lieutenant Colonel Bill Kaneshiro, *supra* note 3, citing industry figures putting the current GPS market at $8 billion and forecasts indicating this market will double every two years for the foreseeable future.
[69] Peter B. de Selding, *supra* note 66.
[70] European Commission, *Galileo - involving Europe in a new generation of satellite navigation services,* Communication, Feb. 10, 1999.
[71] *Galileo: It Turns, supra* note 47; *Satellite Technology: European Commission Urges EU To Develop Its Own Global Navigation System,* European Report, Feb. 13, 1999.

cooperation and coordinated system development.[72] The result will be a more robust and more accurate system for the end-user. It will also foster a highly competitive navigation products market wherein both U.S. and European manufacturers will have equal access to the market, a significant portion of which, including all safety of life operations, will demand GPS/Galileo compatible equipment.

To that end, the Council has issued mandates authorizing the European Commission to negotiate with and strive for cooperative agreements with the U.S., as well as the Russian Federation, concerning GNSS 2.[73] In addition to interoperability issues, the items on the EU's negotiation agenda are the development of a GNSS convention on liability, establishment of a joint management board and agreement on a dispute resolution mechanism.[74] To date, the U.S. has rejected proposals for any such agreements.

The current deployment schedule for Galileo, which projects full operational status by 2008, is driven primarily by three factors. The first two, mentioned above, are the EU's determination to play a significant role in GNSS 2 and their determination to be significant players in the GNSS marketplace. The third is the U.S. GPS timeline which presumably puts Block 2F satellites and their advanced technology in place by 2008 (or at least a majority of GPS is programmed to be Block 2F by 2008).[75] Galileo is expected to provide navigational data much

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[72] *Commission Take Further Step Towards International Cooperation in Satellite Navigation,* RAPID, July 14, 1999.
[73] *Id.*
[74] *Europe Nears GNSS Decision, Presses for Liability Convention,* Aviation Daily, Dec. 11, 1998.
[75] *EC Wants Galileo by* 2008, *supra* note 41; *IIF Forces Europe's Hand on Galileo,* Aviation Daily, Mar. 1, 1999; *See also* World Space Systems Briefings, *supra* note 3, indicating the U.S. has projected that by end of 2008, 18 of the 24 GPS satellites in operation will be Block 2F. *But see* Ray Swider, *supra* note 20, stating that with the planned additional technological upgrades of Block IIF satellites and the longer than expected life span of current GPS satellites, initial operating capabilities of a Block IIF system will not be likely until 2012. For the EU, this means one of two things, either it has more time to achieve its goal of a fully operational Galileo system

more precise than current GPS technology, and accuracy equivalent to or greater than that predicted for Block 2F technology. However, the Europeans fear that if they are unable to make assurances that Galileo will be operational coincident with GPS Block 2F, they will risk losing a significant portion of the market which will only become more dependent on the GPS standard and more willing to accept GPS as the standard by default.[76]

By the close of 1999, the European Commission had signed its definitional phase contract with ESA, as well as four major contracts with industry. The ESA contract, as noted above, will allow ESA to complete its definitional study of Galileo and the ground components of this European GNSS. The contracts with industry, to include Alcatel, Alenia Aerospazio, RACAL and Sextat Avionique, encompass defining the overall architecture of Galileo, services to be provided by the system, EGNOS integration, and standardization.[77] In addition to these steps, the EU has been in talks with the Russian Federation concerning the use of Proton launchers for some or all of the Galileo satellites, access to the L band frequency blocs now held in registration by the Russians, and access to Russian expertise in controlling the space segment of the system.[78] All tolled, it would appear the EU member states have set their sights and are well on their way to deployment of an independent European answer to GPS. While they have hurdles to cross, including the division and sources of financing, determining the military's role and needs,

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(which, given the timetable setbacks that such technological intensive efforts often experience, may be just the breathing room previous EU estimates needed), or if the EU is able to meet its current planned deployment timeline, it will have an edge in its quest to attain a significant share of the GNSS market in that for at least some period during the 2008-2012 time frame it will conceivably have the better GNSS product to offer consumers.

[76] *IIF Forces Europe's Hand on Galileo, supra* note 75; *but see* note 75.

[77] *The European Space Agency and the European Commission Sign Contracts for the Galileo Programme, supra* note 44; *European Space Industry Teams Up for Satellite Navigation Programme Galileo, supra* note 44.

[78] *Satellite Technology: European Commission Urges EU To Develop Its Own Global Navigation System, supra* note 71.

building a mechanism to manage and oversee the system, the momentum and support within government and industry alike would suggest that betting against this public-private venture's success would be ill-advised.

Current U.S. Policy on the Operation and Management of GPS

The current U.S. policy on the control and management of GPS is certainly rooted in its beginnings. At its outset, though GPS was designed as a dual-use system, its primary purpose was to enhance the effectiveness of U.S. and allied military forces.[79] Admittedly, it is unlikely that in the early 1970s anyone truly foresaw the explosion of dual-usage applications of GPS (i.e. military and civilian), usage that has cut across all traditional boundaries and made GPS an international asset. As such, U.S. policy developed with a distinct military bent with minimal deference given to the commercial and foreign affairs ramifications of GPS procedures and guidelines.

Current operating procedures call for continued access to Standard Positioning Service (SPS) on a worldwide basis. This aspect of U.S. policy is of foremost importance. Two different signals are transmitted from GPS satellites: the Precision, or P-code, and the Coarse/Acquisition Code or C/A code.[80] The P-code provides PPS (Precision Positioning Service) and is only available to the military and allied forces, and other authorized users as permitted by DOD.[81] This code can be encrypted to further ensure against civil access. The C/A code provides SPS

[79] Presidential Decision Directive (hereinafter PDD) NTSC-6, *U.S. Global Positioning System Policy,* Mar. 29, 1996.
[80] FRP, *supra* note 3 at C-5.
[81] *Id.* at C-6.

(Standard Positioning Service).[82] SPS is available to any and all users worldwide. SPS is less accurate than PPS and can be manipulated by SA (selective availability), a measure which serves to intentionally degrade the accuracy of the SPS service.[83] The U.S. has elected to use the SA measure, and, but for brief periods since GPS became operational, has intentionally degraded the accuracy of data provided by GPS satellites.[84]

Still yet another aspect of U.S. GPS policy is its decision to provide access to GPS signal data, albeit in a degraded format, to any and all users on a global basis free of charge via SPS.[85] Clearly, given the current ability to deny access to and degrade portions of the GPS signal architecture, DOD could certainly have denied access to GPS signal to all but authorized users, or encrypted the signal and charged users or taxed users for access to decoding technology, or charged for access to corrections to SA inserted error. In any event, whether to a) court continued taxpayer support for the program, or b) motivate industry to devote research funds to GPS developments by holding out the opportunity for the development of a commercial civil market, or c) with the knowledge that others would be developing compatible systems, to cultivate reliance on GPS by all users thereby giving U.S. industry an opportunity to get a leg up on foreign competition and garner a significant share of the global GNSS market, the decision was made during the early stages of GPS development that GPS would be developed as a dual use system, albeit its primary purpose being to enhance U.S. and allied military forces.

Until 1996, GPS policy called for sole control and management of GPS to lie with DOD. While the system itself, its development, control and operational responsibility still reside with

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[82] *Id.*; Lieutenant Colonel Bill Kaneshiro, *supra* note 3.
[83] Rand Corporation, *supra* note 6.
[84] *Id.*
[85] PDD, *supra* note 79; The White House, Office of Science and Technology Policy, National Security Council (hereinafter OSTP), *U.S. Policy Statement on the GPS,* Mar. 29, 1996.

DOD entities, the management of GPS was altered in 1996 to provide for the formation of an interagency GPS Executive Board (IGEB) chaired jointly by DOD and Department of Transportation (DOT), with the participation of other departments and agencies as appropriate.[86] This move seemed to be motivated by the recognition of the exponential growth of civil GPS applications and usage, and that while GPS' primary purpose may yet be to enhance military effectiveness, it is abundantly clear that civil applications of GNSS far outnumber military usage. DOT is to serve as the lead agency for all civil GPS matters to include transportation and commercial sectors.[87] Such policy decisions have allowed and continue to allow the U.S. to wholly control access to GPS, the integrity of GPS data, and, subject to operational and atmospheric anomalies, the reliability of GPS data.

Three major policy commitments since 1996 have presumably, or will when they are effectuated, loosened the constraints on data integrity and access for civil use. In the 1996 Presidential Policy Directive (PDD) NTSC-6, the U.S. committed itself to eliminating GPS degradation through SA by 2006.[88] The intent was to exhibit the U.S. commitment to making more precise navigation and position information available to the civil community, while allowing the military a ten year transition period to adapt their operational plans to a GPS environment wherein nonmilitary users would no longer be hampered by SA.[89] In 1997, DOT and DOD, spurred on by The White House Commission on Aviation Safety and Security, committed the U.S. to providing a second frequency signal for civil use on the L2 signal, which

[86] PDD, *supra* note 79; OSTP, *supra* note 85.
[87] Joseph Canny, U.S. Deputy Assistant Secretary for Transportation Policy, comments to 35th CGSIC Meeting, Mar. 28, 2000, available at www.navcen.uscg.mil.
[88] PDD, *supra* note 79; OSTP, *supra* note 85; *See* Joseph Canny, *supra* note 87, suggesting that the target date for turning off SA has been moved up whereby it may be possible to turn off SA at some point during CY 2000.
[89] OSTP, *supra* note 85.

to date only carried signals accessible by military authorized users.[90] Civil users still would not have access to PPS, but by tying the service available to civil users to the L2 signal, the U.S. virtually guaranteed uninterrupted access to GPS data.[91] At the same, DOT and DOD agreed to cooperate in the establishment of a third signal for civil use. Those efforts came to fruition with Vice President Gore's March 1998 announcement that a third civil signal would be added to GPS at a yet to be determined frequency though it is commonly referred to as L5.[92]

When announced, the U.S. was committed to ensuring the L2 civil signal was available to users by 2005, with the L5 signal following on its heels. The L2 signal will become available as the remainder of the Block 2R satellites are modified for such transmission and are subsequently launched into orbit.[93] It is expected, as noted above, that such modifications will contribute to delaying the launches of the remaining Block 2R satellites which were previously scheduled to be completed by 2002. The yet to be defined L5 signal will not be available for use until Block 2F satellites come on line.[94] With the Block 2R schedule alteration, and the needed design changes for the Block 2F satellites, the Block 2F anticipated launch schedule has been moved back to a 2005 start date.

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[90] Office of the Assistant Secretary of Defense (Public Affairs), News Release, Reference Number 095-97, Feb. 27, 1997; FRP, *supra* note 3 at 3-9

[91] *Id.*

[92] United States Department of Transportation, Office of the Assistant Secretary for Public Affairs, Press Release, *GPS to Provide Two New Civilian Signals,* March 30, 1998; Office of the Assistant Secretary of Defense (Public Affairs), News Release, Reference Number 139-98, March 30, 1998; FRP, *supra* note 3 at 3-9. *See* Kanwaljit S. Sandhoo, Christopher Hegarty, Sally Frodge, A.J. Van Dierendonck, Lt. Col. Richard L. Reaser, and Edward Drocella, *Bandwidth Requirements For an Additional Radionavigation Satellite Service Allocation,* Proceedings of The 12th International Technical Meeting of The Satellite Division of The Institute of Navigation, Sep. 14, 1999 for a discussion of their proposal to assign additional radionavigation signals in the 1164-1188 MHz bandwidth. *See also* J.J. Spilker and A. J. Van Dierendonck, *Proposed New Civil GPS Signal at 1176.45 MHz,* The 12th International Technical Meeting of The Satellite Division of The Institute of Navigation, Sep. 14, 1999.

[93] Ray Swider, *supra* note 20.

[94] *Id.*

Consequences and Fallout of United States Policy

Financial

Current U.S. policy, as noted above, retains full control and ownership of GPS within the autonomy of the U.S. The U.S. has confirmed this commitment on various occasions when it has been presented with opportunities, most notably by the EU and the Russian Federation, to join in an international partnership in pursuit of a single GNSS construct.[95] Citing national security concerns, the U.S. has elected to forego such opportunities as, admittedly, is its prerogative as the financiers and owners of GPS.

One of the results of this decision to retain autonomous control is purely financial. Estimates of expenditures to date suggest the U.S. has spent approximately $15 billion developing and deploying GPS. [96] Annual maintenance, development and upgrade costs average are about $500 million, with the newest generation satellites, Block 2R and 2F, ranging between $30 and $40 million per copy. [97] The decision to provide GPS free of charge has resulted in the U.S. financing the entire GPS budget to date.

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[95] Neil Kinnock, *supra* note 63; *See* Michael Milde, *Solutions in Search of a Problem?: Legal Problem of the GNSS,* Annals of Air and Space Law, Volume XXII-II (1997), citing the statements of the United States and the Russian Federation promising continuous worldwide access to GNSS data on a unilateral basis exhibiting no interest in entering into conventions or international agreements relating to GNSS; *See also* Julie Kamer, United States Department of State, comments to 35th CGSIC Meeting, Mar. 28, 2000 indicating U.S. position was focused on cooperation with EU and their development of Galileo; *See also Europe Nears GNSS Decision, Presses for Liability Convention, supra* note 74.
[96] World Space Systems Briefing, *supra* note 3.
[97] *Id.*

Aside from placing the financial burden of GPS entirely on the U.S. coffers, the no fee decision has resulted in a virtual monopoly hold on GNSS for the U.S. Without financial incentive, competitors have been unwilling or unable to join the market. This has given the U.S. a substantial strategic edge from a national security perspective, but it has also given U.S. industry a firm foothold in the commercial GPS market. As discussed above, it is these same commercial opportunities that are in part motivating the EU to the deployment of Galileo, for despite the inability to draw significant revenue from a GNSS system (due to GPS policy), the marketplace opportunities for EU industry can have a tremendous upside affect on EU economy.

Liability

As the sole party responsible for GPS, any liability that may arise relating to or having a nexus to the ground, control, or space segments of GPS would fall squarely on the U.S. This area of legal liability has been the subject of several in-depth analyses.[98] At this point, this discussion will only briefly highlight the currently available potential avenues for claims or suits against the U.S. as the sole responsible operator of GPS.

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[98] Ruwantissa I.R. Abeyratne, *State Responsibility in Classical Jurisprudence: Reflection on the Global Navigation Satellite System,* Annals of Air and Space Law, Vol XXIII, 1998; Jonathan Epstein, *Global Positioning System (GPS): Defining the Legal Issues of Its Expanding Civil Use,* 61 J.A.L.C. 243, 1995; Paul B. Larsen, *Legal Liability for Global Navigation Satellite Systems,* Proceedings of the Thirty-Sixth Colloquium on the Law of Outer Space, 1993; Kevin Spradling, *The International Liability Ramifications of the US NAVSTAR Global Positioning System,* Proceedings of the Thirty-Third Colloquium on the Law of Outer Space, 1990.

Liability Under Domestic Law

Under domestic law, four statutes allow for potential exposure of the U.S. to liability for losses incurred due to, in whole or in part, GPS failure. These statutes represent those areas wherein the U.S. has elected to waive its sovereign immunity and be subject to liability claims.

The Federal Torts Claims Act (FTCA) allows for claims caused by

> ... the negligent or wrongful act or omission of any employee of the Government while acting in the scope of his office or employment under circumstances where the United States, if a private person, would be liable....[99]

This waiver of immunity is not a blanket waiver but is mitigated by several exceptions. The two most applicable exceptions of consequence in normal day-to-day operations of GPS are the discretionary function exception [100], and an exception for claims arising in a foreign country.[101]

The Suits in Admiralty Act (SAA)[102]provides an avenue for claims which arise on the high seas or U.S. navigable waters, pose a potential threat to maritime commerce and are substantially related to traditional maritime activity.[103]

The Foreign Claims Act (FCA) is a vehicle wherein the U.S. may provide compensation for losses incurred by individuals outside the U.S. as a result of military related activity.[104] The

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[99] 28 U.S.C. 2671, et.seq.

[100] 28 U.S.C. 2680 (a), wherein the conduct of an employee acting within the confines of a discretionary function shall not be subject to liability. See Dalehite, et. al. v. United States, 346 U.S. 15 (1953); Ingham v. Eastern Air Lines, Inc., 373 F.2d 227 (1967); United States v. Varig Airlines, 104 S.Ct. 2755 (1984).

[101] 28 U.S.C. 2680, of note here is that the emphasis is on where the claim arises, which is not necessarily coincident with the location of the injury or loss. *See also* Kevin Spradling, *supra* note 97 for discussion on how losses, though incurred in a foreign land, may nonetheless arise from acts within the United States thereby barring defenses citing such exception.

[102] 46 U.S.C. 741, et.seq.

[103] Sisson v. Ruby, 497 U.S. 358 (1990). *See* Jonathan Epstein, *supra* note 98 for a discussion on the applicability of the Suits in Admiralty Act to GPS.

[104] 10 U.S.C. 2734.

FCA does not provide a path for the litigation and judicial adjudication of a claim, but is solely an administrative regime. It was established during World War I as a diplomatic measure allowing for foreign governments and foreigners to be compensated for damages caused by American military forces without having to avail themselves of the U.S. judicial process or seek remuneration from individual servicemembers.[105] Under the FCA, the U.S. is permitted to settle claims for damage or loss to a foreign country or an inhabitant of a foreign country where the damage or loss occurs outside of U.S. territory and is caused by, or incident to, a military related activity. While it provides for no judicial recourse, neither does it undermine a claimants rights they would otherwise hold under the FTCA, or foreign or domestic tort law. In that GPS is controlled chiefly by the U.S. Air Force, this administrative measure could be a factor if damage were to result from U.S. Air Force actions pursuant to GPS operations.

The Military Claims Act (MCA) permits a service secretary, or its designee, to settle claims filed by citizens and inhabitants of the U.S. and persons in a foreign country who are not inhabitants of that country, for wrongful or negligent acts or omissions of armed forces personnel acting within the scope of their employment which cause damage or loss.[106] For a GPS caused loss, this statute may be applicable given, as mentioned above regarding the FCA, the U.S. Air Force's sole responsibility for the GPS space, ground and control segments. The statute lists several exceptions to such settlement, most significantly the statute does not recognize claims which appropriately fall under another statute's jurisdiction, or claims arising out of combat activities as cognizable under the MCA.[107] As with the FCA, this measure is a purely

[105] David P. Stephenson, Lieutenant Colonel, USAF, *An Introduction to the Payment of Claims Under the Foreign and the International Agreement Claims Act*, 37 The Air Force Law Review 191, 192, 1994.
[106] 10 U.S.C. 2733.
[107] 10 U.S.C. 2733; *See also* Air Force Instruction 51-101, *Law, Tort Claims,* May 1996, Chapter 3.

administrative measure and does not preclude a claimant from asserting his or her rights under appropriate tort law.

Liability Under International Law

Under international law, two instruments are recognized as imposing, at least arguably, liability on satellite operators. They include the 1967 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (Outer Space Treaty), and the 1972 Convention on International Liability for Damage Caused by Space Objects (Liability Convention).

In Article VI, the Outer Space Treaty provides that "States Parties to the Treaty shall bear international responsibility for national activities in outer space . . . Whether such activities are carried on by governmental or non-governmental entities . . ." [108] Furthermore, pursuant to Article VII, Professor Larsen points out that the U.S., as a contracting party to the Outer Space Treaty, has accepted liability

> ...for damages caused by any satellite launched by, or a launch procured by the United States, or one which originates from a U.S. Territory or facility. Article VII will apply whether the damage caused by the satellite occurs in outer space, in air space or on earth.[109]

These provisions are admittedly broad and, having not been thoroughly interpreted by case law, leave much room for debate as to the extent of their jurisdiction. In the case of GPS operations,

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[108] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, Oct. 10, 1967, 18 U.S.T. 2410 (1967).
[109] Paul B. Larsen, *supra* note 97 at 71.

it would appear that Articles VI and VII would hold the U.S. liable for physical damage or destruction as the direct result of a launch activity, orbital activity, or orbit failure. Beyond such direct mass-to-mass encounters, the application of the Outer Space Treaty's liability is unsettled.

In any event, for purposes of this discussion, it would appear that the second of the above-mentioned instruments, the Liability Convention, to which the U.S. is also a signatory, would circumvent application of the Outer Space Treaty. The Liability Convention was ostensibly drafted to clarify and elaborate on the liability aspects of space operations. Under Article II, "a launching state shall be absolutely liable to pay compensation for damage caused by its space object on the surface of the Earth or to aircraft in flight"[110] Claimants under the Liability Convention are required to bring their claims through their Governments. [111] Though the U.S. Congress has voiced its opinion that the Liability Convention is only applicable to physical damage caused directly by a space object itself (i.e. via some physical impact), the issue is not settled, nor has it been addressed by any adjudicative body. [112] The contrast in viewpoints is extreme and may be illustrated by comparing the two following analyses. Dr. Ruwantissa Abeyratne writes:

> This provision [Article II of the Liability Convention] imposes absolute liability upon States launching space objects, such as satellites, which provide technology and communications for air navigational purposes. Admittedly, neither the Outer Space Treaty nor the Liability Convention explicitly provide remedies for damage caused by technology and communication provided through space objects. However, the "common interest" principle and liability provisions of these two Conventions can impute culpability to States.[113]

On the other hand, Dr. Michael Milde has written:

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[110] Convention on International Liability for Damage Caused by Space Objects, 24 U.S. T. 2391 (1972).

[111] *Id.* at Article IX.

[112] *See* Kevin Spradling, *supra* note 98 for a discussion re various commentators positions.

[113] Ruwantissa I.R. Abeyratne, *supra* note 98 at 17.

> This Convention [Liability Convention] establishes strict liability only for physical impact damage caused by a space object on the surface of the earth or to aircraft in flight and the liability regime does not extend to damage which may be caused by faulty transmission or reception of a signal generated by a space object.[114]

Needless to say, the scope of the Liability Convention is not settled, and perhaps won't be until a Claims Commission is convened to resolve a dispute invoking such issues.

European Union's Policy on Ownership and Implementation of Galileo

From its inception, the EU has been committed to placing and retaining control of Galileo in the civil sector. While the EU sees a role for the military in the usage of Galileo, and is currently querying the military forces as to what role they foresee Galileo playing and the tools they would like to see employed by Galileo, the military establishment has simply been a source of input for the development of Galileo. As is quite obvious, this is in sharp contrast to the development of GPS (and GLONASS for that matter) both of which were developed, launched and are controlled solely by the military who, at least in the case of GPS, continue to play a very significant role in formulating policy.

The EU has also been committed to providing its signal free of charge. Whether the motivation for such position arises from EU policy independently, or as a practical matter in response to the U.S. commitment to providing the GPS without service fees, is subject to debate. Reported comments of EU officials would suggest that, given the U.S. position, other options were never considered or were at least dismissed in short order.[115]

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[114] Michael Milde, *supra* note 95 at 213.
[115] *See Galileo: It Turns, supra* note 47; Neil Kinnock, *supra* note 63; Martine Mamlouk, *supra* note 42; *Satellite Technology: European Commission Urges EU to Develop Its Own Global*

While the EU, as their policy currently stands, is committed to providing service free of charge, such will only apply to Galileo's Open Access Service (OAS) signal.[116] Basically, this OAS signal will provide navigation data commensurate with what is and what will be available to civilian users on the L1 and L2 GPS signals. In addition, the EU intends to offer two additional levels of service, Controlled Access Service (CAS) 1 and CAS 2.[117]

CAS 1, as it is now envisioned, will provide a higher level of service for commercial and professional applications.[118] It will be encrypted and carry a certification of accuracy. Most significantly however, it will provide for liability of the signal provider to the subscribed users of the signal and its data.[119] Basically, the provider will guarantee a minimum rate of availability and access and certain accuracy minimums. Obviously this is a major development. As discussed above, sans a private contractual arrangement such as this, users of GNSS (limited to GPS currently) avail themselves of the service at their own peril. There is no settled means of imposing liability on the U.S. as the GPS provider, nor consensus that any liability even exists. The EU plan puts all those concerns to rest, at least for those who may choose to subscribe to CAS 1. For users, this means that they may market a product which uses or manipulates GNSS to consumers with the added guarantee of CAS 1 availability and accuracy. Not only can such enterprises warranty the operation of their particular piece of equipment, but they can warranty

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Navigation System, supra note 71.

[116] Martine Mamlouk, *supra* note 42; Stefan Bauman, John Owen, Steve Harding, Pascal Campagne, Franz-einrichMassman, and Prof. Jac Spaans, *Galileo User Market Perspective*, Proceedings of The 12th International Technical Meeting of The Satellite Division of The Institute of Navigation, Sep. 14, 1999 at 1378-79.

[117] Martine Mamlouk, *supra* note 42; Stefan Bauman, John Owen, Steve Harding, Pascal Campagne, Franz-einrichMassman, and Prof. Jac Spaans, *supra* note 116.

[118] Martine Mamlouk, *supra* note 42; Stefan Bauman, John Owen, Steve Harding, Pascal Campagne, Franz-einrichMassman, and Prof. Jac Spaans, *supra* note 116; *See also Germany to Play Key Role in GNSS-2, supra* note 47.

[119] Martine Mamlouk, *supra* note 42; Stefan Bauman, John Owen, Steve Harding, Pascal Campagne, Franz-einrichMassman, and Prof. Jac Spaans, *supra* note 116.

the output of the system (presuming CAS 1 is the input). If a customer should incur a loss via the use of the equipment, and the loss stems from a faulty input, the manufacturer may seek indemnification from the Galileo operator for any losses it may sustain as a result of the customer's claim. The EU is of the opinion that such warranty is essential for Galileo, and GNSS in general, to instill consumer confidence in the resource and evidence the operator's confidence in the system and their commitment to providing accurate accessible data.[120] The EU considers this second aspect necessary if the world community is to progress in a timely fashion to a GNSS-based navigation, position and timing infrastructure that will receive the certification of international oversight organizations.[121]

CAS 2 is envisioned as another encrypted signal that will be reserved for safety of life operations and governmental and security functions. Included in these users are all aspects of the transport industry (air, highway, rail), search and rescue, law enforcement, firefighters, etc. It is this service which will require certification by international oversight organizations such as the International Civil Aeronautics Organization (ICAO) prior to approval for use as a sole navigation source.

Note that, as with CAS 1, the CAS 2 signal is encrypted. The EU is geographically situated in an area of the world where they share borders with or are otherwise closely situated to dynamic and less than stable political situations. The EU community believes, in short, that it faces an increased risk of area conflict, and terrorist activity which could threaten access to Galileo data or misuse or abuse of Galileo data.[122] This reasoning clearly suggests that the EU envisions retaining the ability to withdraw or deny access to the no fee OAS signal over selected

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[120] Martine Mamlouk, *supra* note 42.
[121] *Id.*
[122] *Id.*

regions when it deems such restrictions necessary for reasons of Community or state security. The use of encryption will allow commercial, professional, safety of life, and governmental uses to proceed without interruption. It is unclear at this point what the decision making process as to such denials will look like, and where the ultimate decision authority will lie, and how the EU intends to police the CAS 1 and CAS 2 subscribers from improper use (i.e. should an adversary state use its national airline's access to CAS 2 as a means to ensure signal availability and integrity for non peaceful purposes). In any event, the EU does see a need for CAS 1 and CAS 2 to both increase user confidence in the system's integrity, and retain some control for security reasons. Although not as far reaching as the control exercised by the U.S., particularly DOD, over GPS, this framework in some respects mirrors the U.S. policy of denying the most accurate and secure signal data to all but military users.

The EU has been a leader in pursuing a true GNSS system, with global oversight and control. However, its attempt to build such a system using GPS as the cornerstone has met with resistance from the U.S. who is reluctant to relinquish or share any control over GPS.[123] This commitment has served, in part, to motivate the establishment of Galileo.[124] But even as the EU moves forward with Galileo, it is still determined that a true GNSS system will be developed. With that goal in mind, the EU policy is to ensure that Galileo is fully interoperable with GPS, to the point that users will be oblivious to which satellite constellation's signal they are using at any given time.[125] At the same time they see a need for Galileo to also be independent of GPS (and GLONASS such as it is).

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[123] Neil Kinnock, *supra* note 63; *Europe Nears GNSS Decision, Presses for Liability Convention, supra* note 74; *See also Satellite Technology: European Commission Urges EU to Develop Its Own Global Navigation System, supra* note 71.
[124] European Commission, *supra* note 70.
[125] Jurgen Erdmenger, *supra* note 43.

Finally, barring an internationally controlled GNSS construct, or even should such come to fruition, the EU is wholly in favor of developing an international liability scheme to which all participants in the GNSS could turn in the event a loss is suffered as a result of a GNSS failure.[126] Such a proposition was endorsed by a vast majority of attendees at the 1998 ICAO Worldwide Communications, Navigation, Surveillance and Air Traffic Management (CNS/ATM) Systems Implementation Conference in Rio de Janeiro as a recommendation to be studied with hopes of future implementation.[127] As noted above, the EU is convinced that the only way to achieve a truly global GNSS system capable of providing a worldwide navigational construct is to assure all potential users of its reliability and precision, and that the most effective way for GNSS providers to advocate such characteristics is to put their money where their mouths are and open themselves up to liability via a defined process should an operator of some portion of the GNSS fail to fulfill their obligations as a provider. Until such time, the EU is not at all confident that a GNSS system will attain certification by such international oversight organizations, such as the ICAO, necessary for the adoption of GNSS as a stand-alone navigational tool and standard. Given the results of the Rio de Janeiro conference, it would appear that the majority of ICAO, sans the U.S., agrees.[128]

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[126] *Europe Nears GNSS Decision, Presses for Liability Convention, supra* note 74; *See also Satellite Technology: European Commission Urges EU to Develop Its Own Global Navigation System, supra* note 71.

[127] Dr. Ludwig Weber, Director of the Legal Bureau, International Civil Aviation Organization (ICAO), Presentation, Proceedings of The 12th International Technical Meeting of The Satellite Division of The Institute of Navigation, Sep. 14, 1999.

[128] Dr. Ludwig Weber, *supra* note 127 at 987; *Liability Issue Concerns Global Satellite Users,* Jane's Airport Review, Sep. 1, 1998 at 31.

Ramifications of an International GNSS Consortium in Contrast to Current U.S. Policy

As to a Liability Convention

Clearly, a majority of countries, including the Member States of the EU, are eager to see a clear liability standard established to be applicable to all instrumentalities in the GNSS network. While the signal providers are likely the first link which comes to mind when one contemplates the potential causes of damage or loss due to a failed GNSS system operation, there are many other potentially liable players. The current generation of architectural plans for a true GNSS calls for several elements to comprise the system in addition to the satellite systems and their data signal. For example, each country or region will be deploying a Differential GPS or Augmented GPS system which will provide very precise and very reliable navigational data to safety of life operations during critical phases. Several augmentation systems are under development and are undergoing testing.

The EU is deploying EGNOS, as described above, with its component parts of geostationary satellites and ground stations. Japan is proceeding with the development of MTSAS which is founded on a similar architecture with ground stations and geostationary satellites.[129] Australia has recently completed testing of its Augmentation System Test Bed (ASTB) which in its operational form will provide the backbone for a proposed Ground-based Regional Augmentation System (GRAS), or a Space-based Augmentation System (SBAS).[130] The U.S. is in the process of testing and deploying WAAS with original forecasts for initial

[129] Hiroshi Nishiguchi, Japan GPS Council, Comments to 35th CGSIC Meeting, Mar. 29, 2000, available at www.navcen.uscg.mil.
[130] *Australia Completes Tests on GNSS Wide Area Component,* Aviation Daily, June 18, 1998 at 480.

operating capability by the end of 2000.[131] However, recent problems with stability and integrity have set the program back with a revised initial operating capability projection of 2002. [132] In addition, the U.S. intends to complete development of Local Area Augmentation System (LAAS) which will provide even more precise data enabling Category II and Category III applications, however no current funding is available to proceed with prototype construction.[133]

Each of these systems, along with numerous counterparts for other areas of the globe, are necessary for a true GNSS to be fielded. These systems provide the consistent accuracy needed for critical phases of flight. Each of these systems employ critical elements, in addition to the space segment GNSS signal, which will also fall under the umbrella of any international liability convention. Given the outcome of the 1998 Rio conference, it seems unlikely that any GNSS system will receive ICAO certification without some agreed upon liability construct in place.

GNSS satellite signal user states, which for all intents and purposes currently means everyone but the U.S., have a valid interest in seeing a defined GNSS liability convention take shape. Under the Chicago Convention, states retain sovereignty over the airspace over their respective territory.[134] They therefore control the aircraft traveling through this airspace. Under the Chicago Convention, each state is required to maintain air navigation facilities in accordance with minimum standards established by the ICAO.[135] Historically, each member state has established its own domestically controlled air traffic control system in compliance with ICAO standards. On the presumption that the world is moving towards a true GNSS, a user state will

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[131] FRP, *supra* note 3 at 3-13.
[132] Steve Hodges, FAA Satellite Navigation Programs, comments to 35th CGSIC Meeting, March 29, 2000, available at www.navcen.uscg.mil.
[133] FRP, *supra* note 3 at 3-13; Steve Hodges, *supra* note 132.
[134] *Convention on International Civil Aviation,* Dec. 7, 1944, 15 U.N.T.S. 295 (hereinafter *Chicago Convention*), Art. 1.
[135] *Id.* at Art. 28.

be basing, at least in part, a portion of its air traffic control system on data from a space segment over which it has no sovereign control. Without more, they will be in a position of complete reliance on data from another sovereign (currently the U.S.) to fulfull its own sovereign obligations. Should their air traffic control system fail as a result of the space segment's failure, they will face liability without any guarantee of recourse against the space segment operator at whose feet blame for the failure lies. Such is an uneasy proposition for a sovereign to accept, and hence the solidarity displayed at the Rio conference. Obviously the user states always have the option of foregoing subscription to the GNSS system, and continuing to meet its Chicago Convention obligations via existing earth based systems, but such certainly seems to portend a roadblock towards globalization and closer relations among states. In any event, a GNSS system must meet with the approval of ICAO and its standards prior to being accepted for international use. The ICAO is firmly committed to the implementation of a GNSS based worldwide CNS/ATM system. However, it would appear the user states could garner enough votes to forestall or curtail such certification sans an international liability agreement.[136]

From the U.S. perspective, a failure to move a GNSS based CNS/ATM system forward translates into a setback for modernization of its own domestic air traffic control infrastructure. It is widely acknowledged that the current U.S. air traffic control and navigation is severely overwhelmed and in dire need of either upgrade or replacement. The FAA has adopted a strategy of navigational aid (Navaids) replacement via an entirely new navigation system based on GPS augmented by WAAS and LAAS.[137] The current plan calls for a phase-down of current navigational aids beginning in 2008 after WAAS becomes fully operational, which at this point is

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[136] *See generally* Dr. Ludwig Weber, *supra* note 127.
[137] FRP, *supra* note 3 at 3-24; Steve Hodges, *supra* note 132.

projected to be sometime in 2002.[138] Though GNSS is clearly gaining acceptance as a primary means of air navigation, failure to gain global backing of GNSS based navigation could result in international carriers having to maintain navigational equipment on board their aircraft that is compatible with both GNSS based systems and with ground based navaids for flights into those countries which choose not to deploy a GNSS based system without the assurances of a liability convention.[139] While the U.S. may continue forward with its modernization plans within the national air space (NAS), a failure to have its domestic system seamlessly integrated with an international standard would likely be restrictive of international travel and could plausibly raise safety concerns via requiring aircrews to transition between different navigation standards.

The EU, with its commitment (in the absence of an international convention) to contractual based liability pursuant to its operation of Galileo, may well alter the current face of the GNSS legal framework. By providing a contractual means of allocating liability that is acceptable to the ICAO membership, a Galileo based GNSS construct could garner ICAO certification, and approval as a Standard and Recommended Practice (SARP).

A separate issue concerning liability, aside from air navigation, concerns simple market share of the myriad of other uses of a GNSS space segment.[140] Liability for the U.S. regarding GPS, as it currently stands, is based upon those domestic and international instruments

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[138] FRP, *supra* note 3 at 3-26; Dave Olsen, FAA Satellite Navigation Programs, Comments to 35th CGSIC Meeting, Mar. 28, 2000, available at www.navcen.uscg.mil; Steve Hodges, *supra* note 132.

[139] *See* Paul B. Larsen, *Should GNSS Standards That Are Uniform For All GNSS Users Be Established, Or Are Unimodal Standards Satisfactory?*, Proceedings of The 12th International Technical Meeting of The Satellite Division of The Institute of Navigation, Sep. 14, 1999 at pp 956-57 for a discussion regarding the establishment ICAO SARPs and member states obligations as to such standards.

[140] Mitre, *supra* note 4, discussing the numerous applications of GPS signal data, both current and proposed, including power grid interfaces, surveying, personal navigation, agriculture, shipping, recreation, mapping, offshore drilling, communication network synchronization and timing, public safety, environmental management, etc.

previously discussed, the application of which is vague at best and which the U.S. has yet to take steps to clarify. If Galileo proceeds as now envisioned, it will provide a definitive framework for liability via a contractual relationship, a feature which may be quite appealing to a variety of users providing for a drop in GPS' market share of GNSS demand.

The U.S. position regarding GNSS liability is staked on the premise that the existing liability regimes are sufficient and robust enough to absorb the introduction of GNSS.[141] The one issue which this position does not address is that discussed above (i.e. by what avenue may a state seek compensation from the U.S. for space segment failures causing damage or loss in the course of domestic CNS/ATM operations in such state's territory).

If the U.S. were to take the initiative at this point in time while it still holds a relative monopoly on the space segment of GNSS, it would undoubtedly be in a much stronger position to steer the course of discussion and the ultimate content of an international liability convention or agreement. It would also nullify any market advantage the EU would otherwise hope to attain by calling user attention to the EU's willingness to expose itself and its Galileo operations to liability via contractual arrangements. The U.S. would also secure for itself a stake in any ICAO certified GNSS by assuaging the concerns of ICAO members hesitant to support a system the operating of which they perceive as accountable to no one. The result would likely be global support for a true GNSS which can only aid in accelerating the deployment and adoption of a worldwide single uniform standard GNSS system.

[141] Michael B. Jennison, Assistant Chief Counsel, International Affairs, Federal Aviation Administration, *The International Law of Satellite-Based Navigation Aids,* Proceedings of The 12th International Technical Meeting of The Satellite Division of The Institute of Navigation, Sep. 14, 1999 at 994.

International Management Initiative

With the commitment to provide three separate civil signals undegraded by SA for worldwide peaceful use, the U.S. has essentially given its word to the the world at large that GPS data, at least SPS, will always be available. The U.S. has in essence, barring exigent circumstances, surrendered its ability to block or degrade the GPS civil signals. Given these declarations, the U.S. could now give substance to that committment by allowing a multilateral structure to oversee and manage the providing of the SPS signal structure.

As suggested by the EU in earlier negotiations, the U.S. could become party to a multilateral agreement or convention wherein oversight and management of GPS, or a portion thereof, would be relinquished to a multilateral body.[142] Such would allow for assurances that the availability of GPS would remain uninterrupted to all users without the lingering uncertainty that the U.S. may unilaterally block signal access to a user or users. This is not to suggest that the U.S. need relinquish control over the entire GPS operation to such an undertaking. This multilateral oversight committee could merely be empowered to determine when and if SPS signals should be denied to any user or users. The concern expressed by the EU, as well as the majority of the Rio conference attendees, aside from their liability concerns, has focused on guaranteeing signal availability, and in the case of the EU, weening itself of dependence on the U.S. and its good faith for GNSS signal access. No party has expressed misgivings that it has been unable to commit time, people, or money to the actual research, production, deployment, or

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[142] Neil Kinnock, *supra* note 63; *Europe Nears GNSS Decision, Presses for Liability Convention, supra* note 74. *See also USA Warns Europe Against GNSS-2 Satnav System*, Air Transport Intelligence, Jan. 29, 1999.

maintenance of GPS ... their concern is access. Putting the availability decision into the hands of a multilateral body would assuage those concerns.

This body could base their decision whether to deny access upon its assessment of a party's use of GPS for non-peaceful purposes, or to assist in the proliferation of non-peaceful conduct.[143] That conduct which rises to a level of non-peaceful purpose would clearly need delimitation, but such could be arrived at by this body drawing on the decisions and experiences of other entities which have engaged in similar line drawing such as the United Nations General Assembly. Establishing this criteria is not the point of our discussion here, it is only highlighted to note that this is not an unprecedented task in international relations.

What is more, assuming Galileo comes to fruition, the EU could place its OAS signal under the management of this same body. Given the EU's previous callings for such an international management entity, one would think it unlikely that the EU could muster much resistance to such a demand from the international community. A marrying of the management of these open source assets could have a positive effect on U.S. national security concerns as will be discussed later.

The Benefits of an International Construct to National Security

U.S. national security concerns regarding GPS seems to be driven by two primary issues: 1) retaining the ability to deny others' access to precise navigational data while keeping such access open to U.S. and allied military forces; and 2) to preclude losing friendly access to data via an adversary's jamming of the GPS signal. The focus of late has seemed to be on precluding

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[143] *See* PDD, *supra* note 79. The PDD calls for the providing of SPS for peaceful civil, commercial and scientific use on a a continuous worldwide basis, free of direct user fees.

the latter.[144] Perhaps with the recent developments in the area of information warfare and the realization of its usefulness in terrorist activities and military operations, U.S. efforts to prevent a successful information warfare attack against the GPS system has been moved to the forefront.

With the issuance of PDD NTSC-6 and its commitment to turn off SA by 2006, and the EU's attention focused on providing precise navigational data without degradation via Galileo, moving anti-jamming efforts up in priority would seem to reflect a proper focus. With the assumption that Galileo comes on line in the near future, denying access to GPS, or at least the SPS signal, becomes a pointless exercise. Once Galileo is on-line, unilateral attempts by the U.S. to deny access to GPS to an adversary would be of no strategic or tactical value. If the U.S. were to deny GPS access to an adversary, the adverary would still likely retain access to precise navigational data via Galileo's OAS. U.S. efforts to gain coalition support for its objective of denying access to an adversary would require persuading the EU to join in a GNSS data boycott of a particular user or users. This would require currying the support of the EU members, which by 2008 will number over 20, not all of whom with the U.S. has had the warmest of relations. Under this scenario, retention of sole control of GPS SPS access does little to advance national security.

However, returning to the proposition of having a single international management body overseeing GNSS signal availability, should the U.S. (or any other state) wish to pursue denial of GNSS data or capability to an adversary state, the focus of their diplomacy efforts would be on this oversight body. Should this body, which would retain access control over both SPS and

[144] *See* Lieutenant Colonel Bill Kaneshiro, *supra* note 2. Lt Col Kaneshiro offered that one of reasons for the delayed launch of the Block 2F satellites was the decision to add on anti-jamming technology. *See also Jamming fo GPS is Opposed; Coast Guard Worried Pentagon May Affect Navigation,* The Washington Post, Mar. 13, 1999 at A2 discussing the Pentagon's efforts to run GPS jamming exercises to test anti-jamming capabilities and train military crews to transition from GPS navigation to alternative means and continue with operations.

OAS, agree with a requesting party's stated objective, denial of all precision navigation data could be denied with the rendering of one decision.

The second offered premise underlying national security concerns and GPS refers to undermining adversary attempts to jam, or deny friendly access to, GPS signals. In what may appear to be a perverse twist of logic, opening control of SPS access to an international body may aid in attaining this goal. By cultivating assurances of access to GPS such a body would bring to the GNSS users, reliance on GNSS related technology would increase. GNSS receiver technology is a relatively cheap technology accessible by almost all states and organizations. By tying communications, navigation, targeting, and information technologies to a GNSS based infrastructure, and cultivating dependence on those technologies, it may be possible that an adversary may be dissuaded from resorting to an information warfare attack aimed at degrading or jamming GPS for fear of undermining its own GNSS dependent assets.

The Benefits of Allocating Funding Among Signatories

As noted earlier, the cost of sustaining and maintaining GPS is currently running at about $500 million per year.[145] Offering to relinquish SPS signal access management to an international oversight body could certainly warrant the U.S. conditioning such arrangement on financial contributions of member states to the GPS budget. Such contributions would serve to defray the annual operating costs which, obviously, are currently drawn solely from the U.S. fisc thereby freeing up funds for other programs.

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[145] World Space Systems Briefing, *supra* note 3.

Aside from the obvious benefit of reducing U.S. expenditures, assessing such charges may well serve the additional purpose of providing smaller and less developed countries a vested interest in the success and sustainment of GPS. While the $500 million figure does not loom large on the U.S. budget, a fraction of that sum imposed on a small, undeveloped country represents to them a not insignificant investment. Such investment may serve to motivate state actors to more enthusiastically embrace the GNSS concept and move it forward by promoting GNSS and augmented GNSS infrastructure within their own territories thereby fueling the movement towards a single universal GNSS standard.

The Benefits of Creating a Market for the U.S. WAAS and LAAS Industry

The U.S. and U.S. private industry have made significant investments in the development, design, production, and testing of the WAAS and LAAS augmented GPS navigation systems. As noted earlier, other countries are also engaged in the design and testing of augmented or differential GPS systems. As GNSS becomes the standard, and terrestial based navigation aids become obsolete, there will be a significant market for such augmented systems. Not all countries have the resources or capabilities to enbark on a DGPS development program such as the EU, Japan, and the U.S. Furthermore, unless a country anticipates that its national industries will be able to develop an augmented navigation system which they can offer into the marketplace as a viable competitor to WAAS/LAAS or EGNOS or MTSAS, it would not be cost effective to engage in such development.

By moving sooner rather than later towards a liability agreement and an international management board, the U.S. may allow its industry to capitilize on its current competive edge in the augmented GNSS field. Taking advantage of its position as the sole space segment provider and forging international agreements which adopt GPS as the accepted standard, the U.S. not only attains one of the stated goals of PDD NTSC-6[146], but potentially creates a global market for U.S industry which has already made significant investments in the research and development of GNSS infrastructure and its component parts.

The Benefits to Sustainment of U.S Technological and Industrial Base

In the same vein as discussed above regarding capitilizing on a created demand for augmented GPS systems, and though perhaps more appropriately addressed as a national security issue, one cannot overlook the importance of sustaining U.S. industry. Should the U.S. opt to not pursue either an international liability or joint management construct, the user market not otherwise tied to GPS may well find the Galileo system, with its contractual liability scheme and civilian control, a more attractive option as the primary service provider for its various applications. Such a shift could well serve to damage U.S. industries which support and service the GPS market, or force them to focus their efforts on the Galileo user market.

Historically, those industries which DOD relies upon for the development of new technology and equipment have faced fiscal uncertainty during times of military draw down and peacetime. With DOD manning at its lowest point in decades and a DOD budget which continues to shrink as a percentage of GNP, DOD and industry are certainly in the midst of lean times. During such times, the government has sought to sustain the military-industrial complex in some fashion so as to precluded its demise by allowing or encouraging industry to seek and provide equipment to customers outside the U.S.

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[146] PDD, *supra,* note 79. The PDD provides that the U.S. will advocate the acceptance of GPS and U.S. Government augmentations as standards for international use.

In somewhat the same way, the technology investment in GPS by private companies, both from a DOD contractor standpoint and a purely private enterprise standpoint, is driven by the ability to garner profits from sales of equipment and support to non-DOD customers. With GPS as the current standard, U.S. companies are able to be very competitive in the GNSS market. If Galileo comes on line as an independent system, with assurances of non degradation, free service and contractual liability, the ability of U.S. industry to sustain a significant share of the market may be jeopardized, and so to will their profits and cash flow, and so to will be their ability to continue corporate investment in GPS and GPS development. They may be forced, without DOD subsidy, to either fold, or significantly rein in their GPS operations, or shift the focus of their GNSS related efforts to servicing the Galileo market. In either event, further refinement and improvement in the GPS market may be stymied.

Conclusion

It would seem apparent that the international community is in full support of and desires the development and deployment of a true GNSS. Technological hurdles aside, the obstacles to an unrestrained embrace of GNSS by the international community center on two issues: liability of space segment providers, and guaranteed availability of the space segment signal.

The U.S. has been opposed to any new international regimes which would attempt to bring control of either of these two issues under a common umbrella. However, the U.S. bases for its position has been, or will be, marginalized. The deployment of Galileo and its promise of provider liability will undermine the U.S. contention that existing liability schemes are robust enough to address GNSS liability issues. Whether or not the U.S. position is accurate will be rendered moot as users find comfort in the known and defined legal construct of contractual liability. Furthermore, the deployment of Galileo, coupled with the U.S.' own commitment to provide SPS without degradation has left U.S. policy which insists on autonomous domestic control somewhat hollowed.

The U.S. is in a position now, as it still holds a monopoly as the sole space segment provider, to seek a liability and a management regime acceptable to the international community that, at least tacitly, adopts GPS as the GNSS space segment standard. Such strides will solidify GPS' hold as the keystone to a true GNSS, secure U.S. industries' competitive position in the GNSS component market and create an environment for more rapid acceptance of a standardized, uniform GNSS . . . all this without any real sacrifice of autonomy or security.

This is not to say that the U.S. should call a summit, draft an agreement, and have it signed by the end of 2000. There are groups, particularly within the ICAO, who are busy grinding through language and drafts of potential agreement text. What I am suggesting is that the U.S. needs to reevaluate the underlying bases for its positions and examine their validity in light of the current changes and forseeable changes in the GNSS environment.

To this point, the U.S. has attempted to dissuade the EU from entering into the GNSS field, rebuffed efforts to negotiate joint management proposals, and dismissed ICAO members' call for a singular liability scheme as wholly unnecessary. The U.S. needs to begin fostering some good will, and tone down its arrogant rhetoric, to put itself in a position where it can begin posturing for the adoption of some legal framework satisfactory to the international community and that at the same time moves the U.S. forward in pursuit of the aims of PDD NTSC-6 (in particular, the adoption of GPS and U.S. augmentation systems as the international standard.)